

FIREFIGHTING FACILITIES AT COAL MINES COMPARED WITH THOSE AT OTHER INDUSTRIAL PLANTS

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* * * * * **Information Circular 7931**



UNITED STATES DEPARTMENT OF THE INTERIOR
Fred A. Seaton, Secretary
BUREAU OF MINES
Marling J. Ankeny, Director

1959

This publication has been cataloged as follows:

Stahl, R Ward.

Firefighting facilities at coal mines compared with those at other industrial plants. [Washington] U.S. Dept. of the Interior, Bureau of Mines, 1959.

12 p. illus., tables. 27 cm. (U. S. Bureau of Mines. Information circular 7931)

1. Coal mines and mining—Fires and fire prevention. I. Title. (Series)

[TN23.U71 no. 7931] 622.06173

U. S. Dept. of the Int. Library

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FIREFIGHTING FACILITIES AT COAL MINES COMPARED WITH THOSE AT OTHER INDUSTRIAL PLANTS^{1/}

by

R. W. Stahl^{2/}

SUMMARY AND INTRODUCTION

A survey of firefighting facilities and practices in coal mines conducted by the Bureau of Mines^{3/} showed such variations in equipment and apparent attitude toward fire protection that a comparison with other industry seemed advisable.

Although other industry is confined generally to surface operations and the hazards probably are not as great, the same general methods of extinguishment are employed, so that the cost and protection at least should be comparable.

An investigation of industry other than mines revealed a generally greater emphasis placed on fire-combating equipment, fire-brigade training, fire-fighting facility inspection, and fire-hazard elimination, as well as a greater average expenditure for fire protection.

Fire is necessary to industrial progress, and civilization would quickly disappear without it, but uncontrolled fire is one of the most destructive forces known and yearly takes many lives and destroys millions of dollars worth of property. The greater the concentration of persons and activity the worse the hazard. Progress necessitates concentration however, and protective measures then become a must.

Coal mines, as compared with other industrial plants, present additional hazards when fire occurs because the surroundings are combustible, access to the fire is limited, explosive gas may be issuing from the coal and strata, a roof fall may suspend explosive coal dust in the atmosphere, and ventilation must be controlled, as fumes and smoke may suffocate workers unless carefully channeled away from the fire-attack area. Few of these difficulties are so pronounced in a surface-plant fire. Escape there is a matter of seconds, while it might take hours to get outside a mine.

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^{3/} Stahl, R. W., and Dodge, C. H., Survey of Fire-Fighting Facilities at Coal Mines: Bureau of Mines Rept. of Investigations 5363, 1957, 37 pp.

This report will deal with the difference in emphasis placed on the fire hazards at some coal mines and industrial plants.

OBJECTIVES

The principal objective of this investigation was to determine how important industry, other than coal, considered fire and what value was placed on protection against disastrous fires. Specifically, the following points were covered:

1. To ascertain what firefighting facilities are available at industrial plants and the maintenance and inspection procedures followed.
2. To compare, as far as feasible, coal-mine fire protection with that in industry.
3. To indicate the expenditure on firefighting equipment at mines and plants comparatively.
4. To set forth good practices at plants that might be useful to coal mines.

SURVEY PROCEDURE

An attempt was made to survey a representative plant in each of several industries to get the widest possible coverage. In addition, data were collected from several plants in the same industry, and it was found that practices were reasonably uniform and consistent, especially in the newer plants. During the plant visits, the location of hydrants, standpipes, hoses, and other water facilities was noted, and the distribution and type of extinguishers in use were checked. Fire-warning signs and signal systems were observed, and in some cases actual fire-brigade practice and fire-fighting demonstrations were seen.

At each plant the inspection and maintenance practices relating to fire equipment were discussed fully with the official in charge of this protection.

FIREFIGHTING FACILITIES

General

As was found at mines, virtually all new plant construction is fire-proof to the fullest possible extent. At plants where economy prohibited demolition and rebuilding, the most vulnerable parts of buildings were fireproofed as much as possible by using fire-resistant paints, changing to fireproof siding or roofing, and installing sprinkler systems.

Although all plants visited are near city fire departments that had agreed to respond to fire alarms immediately, and although in some instances the city departments could be at a fire in less than 5 minutes, the plants still maintain much equipment ready for instant service.

Water Facilities

Reference to table 1 will show a comparison of the water facilities at the best and worst equipped mine and plant visited. It should be noted that the least protected plant had a far greater water supply, as well as much more application equipment, than the best equipped mine. The great advantage in emergency at the plant over the mine was the ready supply at danger spots. Virtually every plant could apply in excess of 200 g.p.m. of water instantly; the best mine had 50 g.p.m. available within 600 feet of the face but no hose nor even an adapter to connect a hose to the supply. Plants generally had 100 feet of 1-1/2-inch hose connected to a standpipe every 200 feet or less. The 2-inch waterline in the best equipped mine terminates 600 or more feet from the remote corners of a working section; 1/2- or 3/4-inch-pipe or hose runs from there to the face, restricting flow to 13 g.p.m. or less.

TABLE 1. - Water facilities

Location	Coal mine	Industrial plant
Best equipped: Surface buildings	150,000-gal. tanks; 450-g.p.m. pump to tank; 6-inch line to fireplug near each building; 600 ft. of 2-1/2-inch firehose and nozzles available.	3,000,000-gal. reservoir; 120,000-g.p.m. pumps, river to reservoir; 54- and 48-inch plant-line loop; 12-inch line loop to hydrants near buildings; 400 ft. of 2-1/2-inch hose attached to each outlet of 2 outlet hydrants; at least 2 hoses reach each point in plant area.
Face area of mine or operational part of indus- trial plant.	150,000-gal. tanks; 450-g.p.m. pump to tank; 6-inch line, surface to mine; 6- and 3-inch lines along haulageways with 2-1/2-inch outlets every 500 ft.; 2-inch line room entries to within 600 ft. of face; 1-inch pipe to face.	2-inch standpipes throughout plant with 100 ft. of 1-1/2- inch hose and combination nozzles attached at least every 100 ft. so that at least 2 hoses will converge on any point; Automatic sprinkler and chemical-foam outlet systems when oil or flammable-liquid operations performed.
Worst equipped: Surface buildings	12,000 gal. tank only; 2-inch line to 1 build- ing; No hose; buckets available.	10,000,000-gal. reservoir; 1,500-g.p.m. pump from river; 10-inch plant-line loop; 6- and 4-inch lines to hydrants not more than 700 ft. apart in plant area; 350 ft. of 2-1/2- inch hose near each hydrant.
Face area of mine or operational part of indus- trial plant.	6-inch borehole acts as well; 4-inch line along main entries in part of mine; 2-inch room en- tries to within 60 ft. of face; 1/2-inch rubber hose to face.	Same as above, except only 1 area equipped for dispensing chemical foam.

Fire Extinguishers

In fire-dangerous parts of a plant 20-pound dry-chemical fire extinguishers generally were found no more than 50 feet apart, with one as close as possible to a machine operator or particularly vulnerable operation. In addition, a 150- or 350-pound dry-chemical, or an 80-gallon foam-type, extinguisher was within 100 feet of a hazardous area, and numerous other similar units could be assembled in a matter of 2 or 3 minutes.

At the best mine visited a 4-pound dry-chemical extinguisher or equivalent was readily available, two 20- or 30-pound dry-chemical extinguishers or equivalent were usually within 300 feet, and one 150-pound dry-chemical extinguisher was within 600 feet of the greatest fire hazard. (See table 2.) Some mines may have more equipment but were not surveyed.

TABLE 2. - Fire extinguishers

Location	Coal mine	Industrial plant
	Mine or cleaning plant ^{1/}	Equivalent hazardous area
Best equipped: Surface buildings	1 100-lb. CO ₂ as backup equipment on 3-floor plant.	At least 40-gal. foam with 40-gal. refill at least every 100 ft. on each floor.
Face area of mine or operational part of industrial plant.	1 150-lb. dry-chemical within 600 ft. of face. 2 20-lb. dry-chemical within 300 ft. of face. 1 10-lb. dry-chemical on each machine.	1 350-lb. dry-chemical within 100 ft. of possible firing operation. 1 20-lb. dry-chemical or equivalent within 20 ft. of operation. Automatic foam dispenser within 100 ft. of operation.
Worst equipped: Surface buildings	2 2-gal. CCl ₄ and 1 4-lb. dry-chemical for 3-floor building.	At least 40-gal. foam with 40-gal. refill every 200 ft. on each floor.
Face area of mine or operational part of industrial plant.	No extinguishers within 600 ft. of face. Usually at least 160-lb. of rock-dust available.	1 40-gal. foam with refill, or 150-lb. dry-chemical within 100 ft. of operation. 1 20-lb. dry-chemical or equivalent within 20 ft. of operation.

^{1/} Offices, shops, etc., about same for mine or plant.

Emergency Equipment

All really hazardous operations in plants were protected by automatic sprinkler systems, foam lines, or CO₂ systems, and self-contained oxygen breathing apparatus was available for firefighters if needed.

The best mine visited had self-rescuers available near each face for all persons employed therein, plus two spares for possible visitors. Firehose and extinguishers were kept at centrally located stations at least 10 minutes from a face or fire-danger area.

Table 3 shows the comparison of materials and equipment available and the time required to assemble these in an emergency.

TABLE 3. - Availability of materials for emergency in critical area

Location	Material	Coal mine				
		Instantly	5 minutes	10 minutes	15 minutes	30 minutes
Best equipped	Water	13 g.p.m. unlimited supply.	80 g.p.m. unlimited supply.	80 g.p.m. unlimited. 100 g.p.m. 2,000 gal.	80 g.p.m. unlimited. 200 g.p.m. 4,000 gal.	80 g.p.m. unlimited. 500 g.p.m. 10,000 gal.
	Extinguishers.	1 10-lb. dry-chemical.	2 30-lb. and 1 150-lb. dry-chemical.	3 150-lb. dry-chemical.	Possibly 10 150-lb. dry-chemical.	20 150-lb. dry-chemical.
	Other.....	Self-rescuer for each person.	(2/)	(2/)	(2/)	(2/)
	Water.....	5 g.p.m.	30 g.p.m.	30 g.p.m.	50 g.p.m.	50 g.p.m.
	Extinguishers.	None	None	None	10 of various types from surface.	No more.
Least equipped	Other	Rock dust	(5/)	(5/)	(5/)	(5/)
Location	Material	Industrial plant				
		Instantly	5 minutes	10 minutes	15 minutes	30 minutes
Best equipped.	Water.....	100 g.p.m. unlimited supply	400 g.p.m. unlimited supply	2,000 g.p.m. unlimited supply	5,000 g.p.m. unlimited supply.	5-plus city fire companies.
	Extinguishers.	1 20-lb. dry-chemical or equivalent.	5 350-lb. dry-chemical.	20 350-lb. dry-chemical foam.	(1/)	(1/)
	Other.....	Chemox or Scott Air-Pak.	Chemical foam.	(3/)	(3/)	(3/)
	Water.....	100 g.p.m. unlimited supply.	200 g.p.m. unlimited supply.	1,000 g.p.m. unlimited supply.	3,000 g.p.m. unlimited supply.	4-plus city fire companies.
	Extinguishers.	1 20-lb. dry chemical or equivalent.	3 40-gal. foam.	10 40-gal. foam.	(4/)	(4/)
Least equipped.	Other.....	-	Chemox and chemical foam.	(3/)	(3/)	(3/)
1/ 100 or more units. 2/ Ample supply of rock dust. 3/ Virtually unlimited chemical foam. 4/ 50 or more units. 5/ 10 or more tons rock dust.						

FIREFIGHTING ORGANIZATION

Each plant visited had a firefighting organization trained at regular intervals in the use of all equipment and ready to function instantly. These organizations varied from the best, which consisted of a full-time fire chief with a fire marshal and 6 firemen on each shift, trained weekly, plus 20 auxiliary firemen, trained monthly, on immediate call and distributed on all shifts, to one where a fire inspector on each shift headed a crew of plant maintenance men trained quarterly. In every instance the training included actual practice drills with mockup fires, using all the various equipment available.

The best mine organizations observed was one where the underground shop foreman directed all firefighting. His helpers were anyone he could assemble from the working force on shift. The only person actually familiar with the equipment was this foreman. Face workers were shown how to operate a fire extinguisher possibly once when it was installed. Dependence was placed generally on the section foreman to direct firefighting, and in many cases he was not familiar with anything except the hand extinguishers in his section. (See table 4.)

INSPECTING AND TESTING EQUIPMENT

At all plants the firefighting equipment was inspected and tagged weekly with a report made to the official in charge of fire protection. In addition, a designated fire inspector made a monthly report on all fire equipment, and an insurance-company inspector made inspections at least quarterly. All water outlets and equipment were use-tested and any needed maintenance performed at 6-month intervals at most plants or at least yearly. Hose was pressure-tested every 6 to 12 months. Fire extinguishers were checked weekly, pressure cartridges weighed quarterly, and the complete unit emptied and overhauled at least yearly.

Fire hose was not tested at any coal mine visited; however, water outlets were flushed yearly. Fire extinguishers at a few mines were completely checked yearly, at others only if and when used. (See table 5.)

FIRE-ALARM SYSTEMS

At most plants a fire-alarm system was used primarily to summon the firefighters to immediate activity. These varied from a most elaborate one with zoned areas and radio connections to a nearby city fire department to a simple gong system, which could be sounded from convenient points throughout the plant area.

No mine visited had a fire-alarm system, although those equipped with trolleyphones could spread an emergency alarm quickly. In most instances the telephone was the means of communication. (See table 6.)

TABLE 4. - Firefighting organization and procedure

Location	Organization	Training	Fire inspection	Procedure in case of fire
Surface mine.	None	Key employees familiarized with fire extinguishers yearly.	Master mechanic checks equipment yearly.	Foreman or master mechanic gathers employees and uses facilities available. Call outside help.
Surface mine with worst facilities.	do.	do.	None	Any employee uses facilities available. Call outside help.
Underground mine with best facilities.	Master mechanic familiar with all fire-fighting equipment.	Master mechanic keeps self familiar with all fire-fighting equipment.	Safety inspector checks equipment monthly.	Master mechanic notified of all fires, gets truck and proceeds immediately. Foreman organizes crew and uses equipment available.
Underground mine with worst facilities.	(1/)	(1/)	(1/)	(1/)
Plant A	Fire-protection committee, 3 fire marshals, 2 fire inspectors, maintenance men form fire brigade each shift.	Fire-protection committee meets every 2 months to discuss hazards and recommend changes. Fire marshals and inspectors trained 3 times yearly.	2 inspectors examine all fire equipment weekly and report on same.	Fire marshals take brigade and proceed at once to fire. Outside fire companies alerted in case needed.
Plant B	Fire chief, 4 fire captains, maintenance men form fire brigade each shift. 20 auxiliary firemen on call.	4 fire captains and brigades get weekly training. Auxiliary firemen 4 hours monthly.	Fire chief full-time directing fire activities. 4 fire captains continuously inspect for fire and safety.	Fire chief notified and outside fire companies alerted to stand by. Fire captains and brigade get truck and proceed to fire.

1/ Mine has none of these organizations and procedures.

TABLE 5. - Tests of fire facilities.

Location	Facility	Test
Best equipped surface coal mine.	Water outlets	Opened and flushed yearly.
	Hose	Visual inspection every 3 months.
	Extinguishers	Completely checked and overhauled yearly.
Best equipped underground coal mine.	Water outlets	Flushed yearly.
	Hose	Visual inspection every 3 months.
	Extinguishers	Monthly inspection and pressure cartridge weighed every 6 months.
Worst equipped surface coal mine.	Water outlets	No inspection.
	Hose	Visual inspection yearly.
	Extinguishers	Refilled and checked after use.
Worst equipped underground coal mine.	Water outlets	None except near face.
	Hose	Never inspected.
	Extinguishers	Refilled and checked after use.
Best equipped industrial plant.	Water outlets	Checked weekly. Tested every 6 months and flushed.
	Hose	Examined weekly. Pressure-tested every 6 months.
	Extinguishers	Complete inspection and recharge yearly. Pressure cartridge weighed every 90 days. Weekly inspection.
Worst equipped industrial plant.	Water outlets	Checked weekly. Tested yearly and flushed.
	Hose	Examined weekly. Yearly pressure test.
	Extinguishers	Weekly inspection. Pressure cartridge weighed every 6 months. Complete inspection and recharge yearly.

TABLE 6. - Fire-alarm system

Location	Coal mine	Industrial plant
Best equipped: Surface buildings	Telephone in all buildings to nearby communities and other mine buildings.	Complete alarm system with panel board in fire station and call-boxes at all strategic points throughout plant, tested weekly.
Face area of mine or operational part of industrial plant.	Telephone within 300 ft. to underground stations and the surface.	Complete alarm system throughout plant with all stations connected to siren and panel board in fire station to give quick location.
Least equipped: Surface buildings	Telephone in office only.	Alarms in all multistory buildings. Telephone direct to local city fire company. Plant siren at gate for emergency.
Face area of mine or operational part of industrial plant.	Telephone within 600 ft. of other sections of mine and shop on surface.	Telephone service to gate where alarm is sounded in emergency.

RÉSUMÉ

A. Figure 1 shows a comparison of similar-size areas in a plant and a mine and the facilities available for fire protection. These may be summarized as follows:

In similar-size areas	Mine	Plant
Exits.....	3	8
Hand extinguishers.....	5	68
Large extinguishers.....	1	4
Water outlets.....	1	16
Water g.p.m. immediately.....	5 - 15	100
Water g.p.m. within 5 minutes..	50	1,000

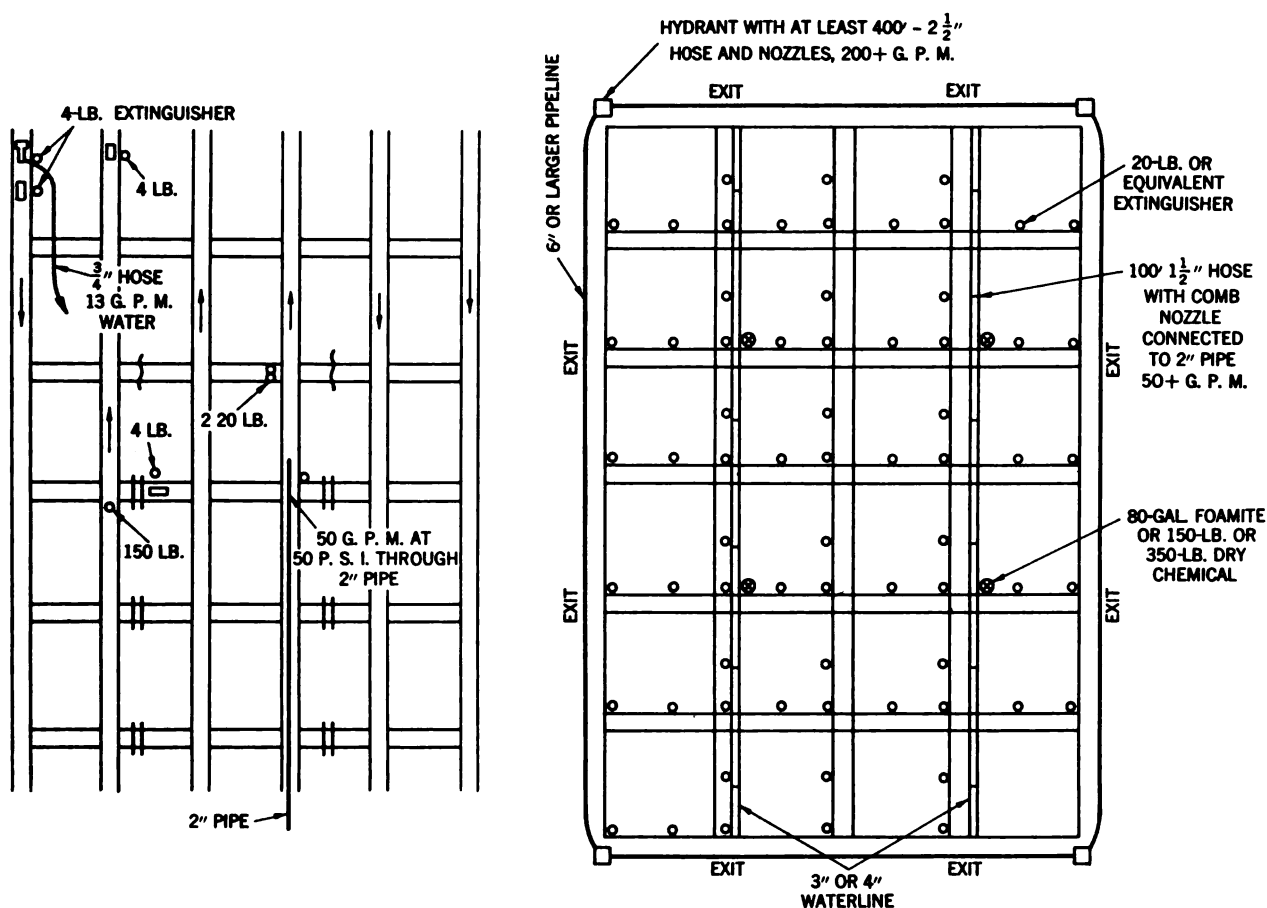


FIGURE 1. - Comparison of Firefighting Equipment in Mechanized Section of Mine and Similar-Size Area of Plant.

B. Figure 2 shows a small area of a mine and a plant with a nearly similar investment in equipment, and the firefighting facilities available. It should be noted that three 4-pound dry-chemical extinguishers are instantly

available in the mine and two 20- or 30-pound dry-chemical and two 150- or 350-pound similar extinguishers are within 100 feet of any possible plant fire. In the mine 5 to 15 g.p.m. of water is instantly ready; in the plant at least 50 g.p.m. of water can be used in seconds.

C. The capital investment in fire protection, compared with the total mine or plant investment is shown in figure 3. It will be noted that the least equipped plant has spent as much in fire protection as the best equipped mine.

D. As a matter of general information, the following list was prepared to show the difference in the amount of equipment for fire protection at an average plant and an above-average coal mine.

<u>Mine</u>	<u>Plant</u>
200,000-gal. tank	11,756 g.p.m. water,
3,000 g.p.m. (pumps)	unlimited supply.
10 miles of 6- and 8-inch pipeline.	15 miles of 10-inch pipeline.
82 2-inch outlets; no adapters	160 2-outlet hydrants.
1,500 ft. of 2-1/2-inch hose	8.4 miles of 2-1/4-inch hose.
850 ft. of 1-1/2-inch hose	4.75 miles of 1-1/2-inch hose.
1 2,100-gal. tank car with 600 ft.	2 1,500-g.p.m. fire trucks
hose and 100-g.p.m. pump.	(complete city type).
2 900-gal. tank cars with 250-ft.	
hose and 100-g.p.m. pump.	
10 nozzles	299 fire-hose nozzles.
150 portable fire extinguishers	1,352 portable fire extinguishers.
	79 miles of Foamite piping from
	tanks with outlets convenient to
	all operations.
	427,000 gal. of Foamite solution.
	86 tons of Foamite powder in stock.

SUGGESTIONS

This study indicates that if mines desire to approach the degree of protection now existing in other industry, the following would not be unreasonable:

1. At least one larger hand-type fire-extinguishing unit might prove quite valuable if kept in the first crosscut outby the expensive complement of mining equipment found at a working face in a mechanized mine.

2. A 1-1/2-inch hose, long enough to reach the most remote working place, equipped with nozzle and attached to the terminus of the 2-inch pipe in each working section would save valuable time in a fire emergency.

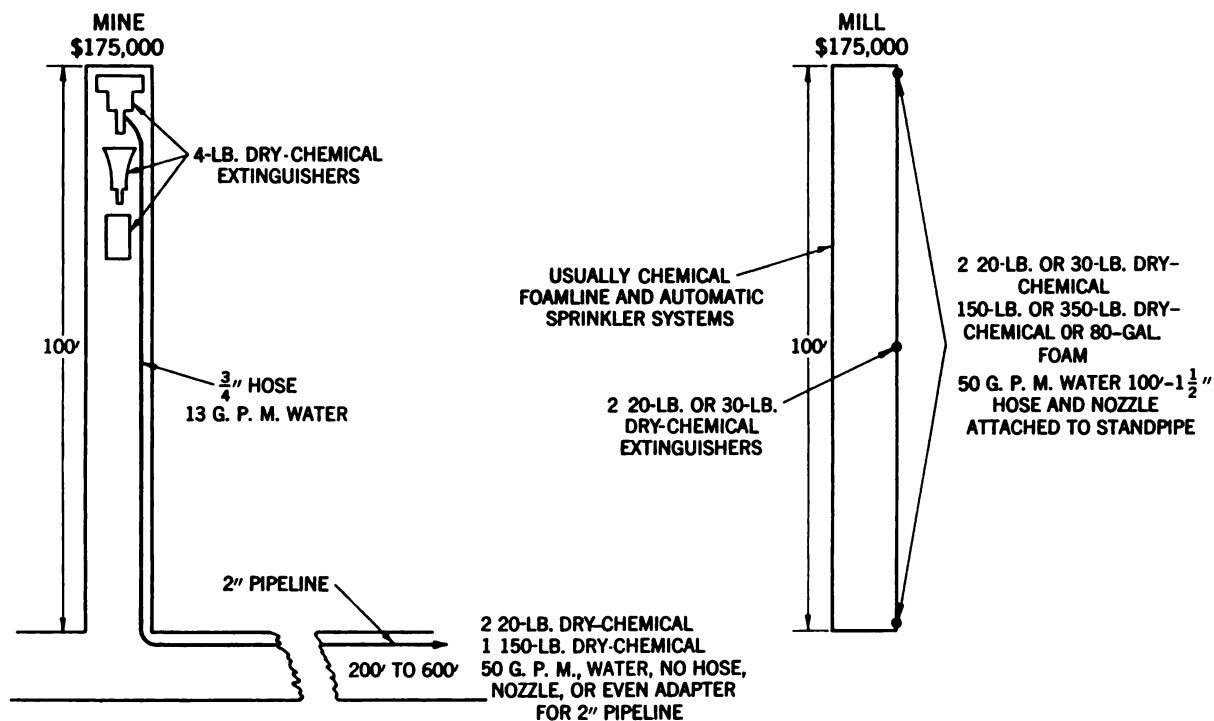


FIGURE 2. - Comparison of Firefighting Equipment in Small Area of Mine and Similar Area of Plant.

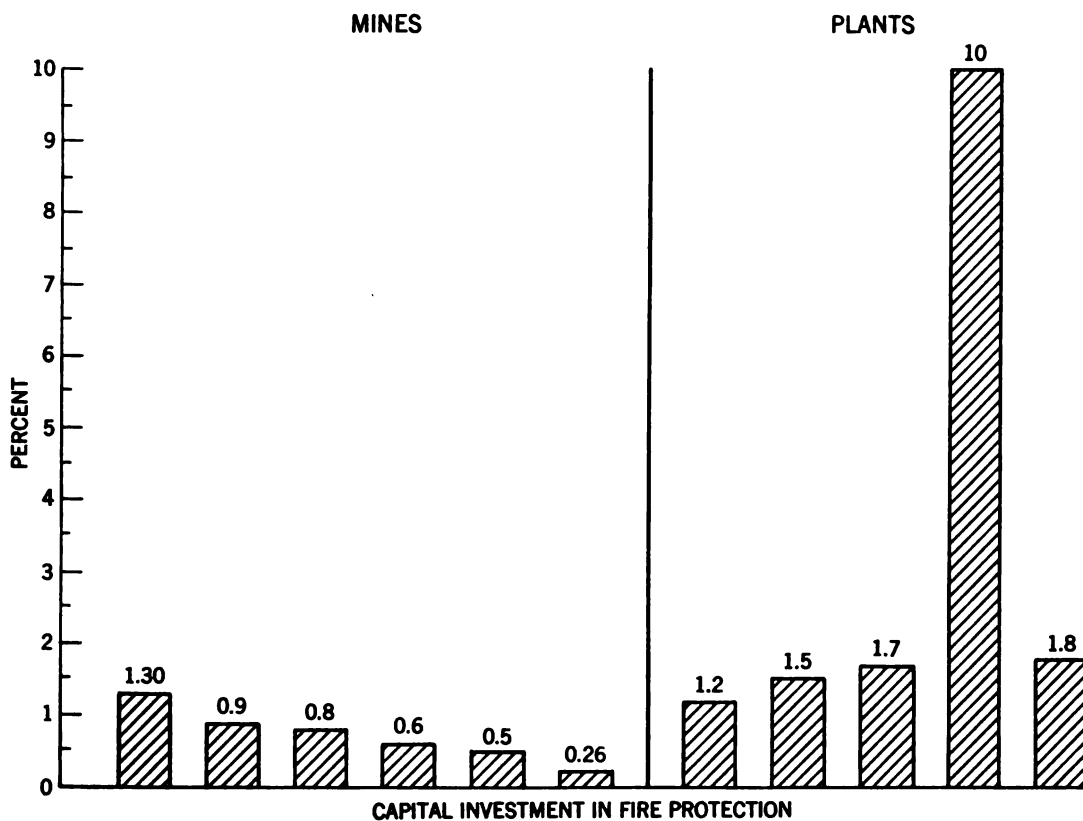


FIGURE 3. - Capital Investment in Fire Protection.

3. Fire drills in each working section and for every crew at least quarterly would emphasize the fire hazard and possibly prevent small fires from getting out of hand.

4. A self-rescuer for each man employed on a section kept in the first crosscut outby the immediate work area would be a great asset.